Ecological monitoring technologies to enhance large-scale microalgae cultivation, stability, and productivity

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Abstract

Global Algae Innovations (GAI) is a leader in algae bioproducts with cultivation advancements demonstrated in one of the world's largest open raceway facilities utilizing power plant flue gas as the carbon dioxide source. In the process, GAI has also developed elite algal strains for the production of bioproducts, yet system-level ecological information is largely unknown. This project will bypass classic approaches of detecting and tracking single organisms using qPCR or LAMP assays to develop and deploy real-time system monitoring methods using 3rd generation long read sequencing technologies. Project aims include testing the suite of Oxford Nanopore Technologies on open pond algal cultures while integrating system-level functional relationships between elite algae strains and the system microbiome. Toolkit and shared learning deliverables will include a combination of a curated algal microbiome database, analysis workflows, and a collection of mitigation strategies from an integrated systems-level approach that can be utilized in a decision tree model. The proposed project will integrate work across a "lab-to-field" model using controlled laboratory-scale experiments that simulate diurnal raceway conditions through computer controlled light level, heating, cooling, air addition, CO_2 addition, mixing level, media addition, and mimic current GAI methods for pond transfer and scale up. Our prior successes for the detection and quantitation of genetic signatures and cultivation of microbiome constituents, including bacteria and viruses in pond systems, is a key first step that allows farm managers to monitor pond communities. This information now makes it possible to engineer polymicrobial systems to prevent or mitigate periods of low productivity while promoting optimal growth of algae pond ecosystems. The experiential information framework connects low-cost, rapid ecological monitoring to accelerate the development of cultivation advances and treatment protocols; making it possible to alert farm scientists of ecological perturbations.